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Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study

Linda H Aiken, PhD,
Center for Health Outcomes and Policy Research, University of Pennsylvania School of Nursing, Philadelphia, PA, USA

Douglas M Sloane, PhD,
Center for Health Outcomes and Policy Research, University of Pennsylvania School of Nursing, Philadelphia, PA, USA

Luk Bruyneel, MS,
Centre for Health Services and Nursing Research, Catholic University Leuven, Leuven, Belgium

Koen Van den Heede, PhD,
Centre for Health Services and Nursing Research, Catholic University Leuven, Leuven, Belgium

Peter Griffiths, PhD,
Faculty of Health Sciences, University of Southampton, Southampton, UK

Reinhard Busse, MD,
Department of Health Care Management, WHO Collaborating Centre for Health Systems, Research and Management, Berlin University of Technology, Berlin, Germany

Marianna Diomidous, PhD,
Faculty of Nursing, University of Athens, Athens, Greece

Juha Kinnunen, PhD,
Department of Health Policy and Management, University of Eastern Finland, Kuopio, Finland

Maria Kózka, PhD,
Institute of Nursing and Midwifery, Faculty of Health Science, Jagiellonian University Collegium Medicum, Krakow, Poland

Emmanuel Lesaffre, PhD,
Leuven Biostatistics and Statistical Bioinformatics Centre, KU Leuven, Leuven, Belgium

Matthew D McHugh, PhD,

Correspondence to: Prof Linda H Aiken, Center for Health Outcomes and Policy Research, University of Pennsylvania School of Nursing, Philadelphia, PA 19104, USA, laiken@nursing.upenn.edu.

See **Online** for appendix

Contributors

LHA, WS, LB, MM, PG, RB, and MTM-C did the literature search. LHA, WS, DMS, KVdH, AMR, PG, MM, RB, AS, and CT designed the study. WS, LHA, KVdH, RB, PG, MD, JK, MK, MTM-C, AMR, RS, AS, CT, and TVA collected data. LHA, DMS, LB, MM, WS, and TVA analysed data. All of the authors contributed to data interpretation, writing, and revision of the report.

Conflicts of interest

We declare that we have no conflicts of interest.

Center for Health Outcomes and Policy Research, University of Pennsylvania School of Nursing, Philadelphia, PA, USA

M T Moreno-Casbas, PhD,
Nursing and Healthcare Research Unit, Institute of Health Carlos III, Madrid, Spain

Anne Marie Rafferty, PhD,
Florence Nightingale School of Nursing and Midwifery, King's College, London

Rene Schwendimann, PhD,
Institute of Nursing Science, Basel, Switzerland

P Anne Scott, PhD,
School of Nursing and Human Sciences, Dublin City University, Dublin, Ireland

Carol Tishelman, PhD,
Medical Management Centre, Department of Learning, Informatics, Management and Ethics, Karolinska Institutet, Stockholm, Sweden

Theo van Achterberg, PhD,
Scientific Institute for Quality of Healthcare, Radboud University Nijmegen Medical Center, IQ Healthcare, HB Nijmegen, Netherlands

Walter Sermeus, PhD, and
Centre for Health Services and Nursing Research, Catholic University Leuven, Leuven, Belgium

for the RN4CAST consortium*

Summary

Background—Austerity measures and health-system redesign to minimise hospital expenditures risk adversely affecting patient outcomes. The RN4CAST study was designed to inform decision making about nursing, one of the largest components of hospital operating expenses. We aimed to assess whether differences in patient to nurse ratios and nurses' educational qualifications in nine of the 12 RN4CAST countries with similar patient discharge data were associated with variation in hospital mortality after common surgical procedures.

Methods—For this observational study, we obtained discharge data for 422 730 patients aged 50 years or older who underwent common surgeries in 300 hospitals in nine European countries. Administrative data were coded with a standard protocol (variants of the ninth or tenth versions of the International Classification of Diseases) to estimate 30 day in-hospital mortality by use of risk adjustment measures including age, sex, admission type, 43 dummy variables suggesting surgery type, and 17 dummy variables suggesting comorbidities present at admission. Surveys of 26 516 nurses practising in study hospitals were used to measure nurse staffing and nurse education. We used generalised estimating equations to assess the effects of nursing factors on the likelihood of surgical patients dying within 30 days of admission, before and after adjusting for other hospital and patient characteristics.

Findings—An increase in a nurses' workload by one patient increased the likelihood of an inpatient dying within 30 days of admission by 7% (odds ratio 1·068, 95% CI 1·031–1·106), and every 10% increase in bachelor's degree nurses was associated with a decrease in this likelihood

by 7% (0·929, 0·886–0·973). These associations imply that patients in hospitals in which 60% of nurses had bachelor's degrees and nurses cared for an average of six patients would have almost 30% lower mortality than patients in hospitals in which only 30% of nurses had bachelor's degrees and nurses cared for an average of eight patients.

Interpretation—Nurse staffing cuts to save money might adversely affect patient outcomes. An increased emphasis on bachelor's education for nurses could reduce preventable hospital deaths.

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Introduction

Constraint of health expenditure growth is an important policy objective in Europe despite concerns about adverse outcomes for quality and safety of health care.[1,2] Hospitals are a target for spending reductions. Health-system reforms have shifted resources to provide more care in community settings while shortening hospital length of stay and reducing inpatient beds, resulting in increased care intensity for inpatients. The possible combination of fewer trained staff in hospitals and intensive patient interventions raises concerns about whether quality of care might worsen. Findings of the European Surgical Outcomes Study[3] across 28 countries recently showed higher than expected hospital surgical mortality and substantial between country variation in hospital outcomes.

Nursing is a so-called soft target because savings can be made quickly by reduction of nurse staffing whereas savings through improved efficiency are difficult to achieve. The consequences of trying to do more with less are shown in England's Francis Report,[4] which discusses how nurses were criticised for failing to prevent poor care after nurse staffing was reduced to meet financial targets. Similarly, results of the Keogh review[5] of 14 hospital trusts in England showed that inadequate nurse staffing was an important factor in persistently high mortality rates. Austerity measures in Ireland and Spain have been described as adversely affecting hospital staffing too.[6,7]

Research that could potentially guide policies and practices on safe hospital nurse staffing in Europe has been scarce. Jarman and colleagues[8] reported an association between large proportions of auxiliary nurses (which implies a low overall mix of nursing skill) and high mortality in hospitals in England. Rafferty and colleagues[9] noted that low hospital mortality in England after common surgeries was associated with nurses each caring for few patients. Research in Belgium[10] found hospital mortality after cardiac surgery was significantly lower in hospitals with lower patient to nurse staffing ratios and in hospitals with a higher proportion of nurses with bachelor's education than in hospitals with higher staffing ratios and fewer nurses with bachelor's education. Likewise, data from a Swiss study[11] suggested significantly increased surgical mortality associated with inadequate nurse staffing and poor nurse work environments.

This nascent but growing scientific literature about nursing outcomes in Europe is complemented by research from North America showing that improved hospital nurse staffing is associated with low mortality.[12] Additionally, growing evidence exists that bachelor's education for nurses is associated with low hospital mortality.[13–17]

Research into nursing has had little policy traction in Europe compared with the USA where almost half the 50 states have implemented or are considering hospital nurse staffing legislation.[18,19] On the basis of findings showing improved outcomes for patients, the Institute of Medicine recommended that 80% of nurses in the USA have a bachelor's degree by 2020,[20] and hospitals have responded with preferential hiring of bachelor's nurses. European decision makers might be unclear about the applicability of research done in individual countries in Europe or North America to Europe more generally. Specifically, scientific evidence is needed to inform the continuing European Union policy debate about harmonisation of professional qualifications for nurses.[21]

RN4CAST, funded by the European Commission, was designed to provide scientific evidence for decision makers in Europe about how to get the best value for nursing workforce investments, and to guide workforce planning to produce a nurse workforce for the future that would meet population health needs.[22] Investigators of the study of 488 hospitals in 12 European countries noted substantial variation between countries with regards to patient to nurse workloads and the percentage of nurses qualified at the bachelor's level.[23] These variations in nursing resources are important predictors of patients' satisfaction with their care and in nurses' assessments of quality and safety of care.[24]

We aimed to assess whether differences in patient-to-nurse workloads and nurses' educational qualifications in nine of the 12 RN4CAST countries with similar patient discharge data are associated with variation in hospital mortality after common surgical procedures. The nine countries are representative of variation in Europe with respect to organisation, financing, and resources given to health services. The study's findings provide previously unavailable evidence to guide important decisions about improvement of hospital care in Europe in the context of scarce resources and health-system reforms.

Methods

Study setting

Data for this observational study were from administrative sources on hospital patients and characteristics of hospitals, and surveys of 26 516 bedside care professional nurses done in 2009–10 in 300 hospitals in nine European countries (Belgium, England, Finland, Ireland, the Netherlands, Norway, Spain, Sweden, and Switzerland). Similar patient discharge data consistent with the patient mortality protocol were not available for three RN4CAST countries (Germany, Poland, and Greece). The study included most adult acute care hospitals in Sweden, Norway, and Ireland, and geographically representative samples of hospitals in the other countries.[22]

The European study protocol received ethical approval by the lead university, Catholic University of Leuven, Belgium. Each grantee organisation in the nine participating countries

received ethical approval at the institutional level to do nurse surveys and analyse administrative data for patient outcomes. We also obtained country level approvals to acquire and analyse patient outcomes data.

Outcomes

We obtained patient mortality data for postoperative patients discharged from study hospitals in the year most proximate to the nurse survey for which data were available, which ranged between countries from 2007 to 2009. Our analyses included patients aged 50 years or older with a hospital stay of at least 2 days who underwent common general, orthopaedic, or vascular surgery, and for whom complete data were available for comorbidities present on admission, surgery type, discharge status, and other variables used for risk adjustment. We used the procedures published by Silber and colleagues[25] to define common surgeries and comorbidities (appendix). We selected common surgeries for study because almost all acute hospitals undertake them, risk adjustment procedures for surgical patients have been well validated, and risk-related comorbidities can be more accurately distinguished for surgical patients than for medical patients because they are present at admission by contrast with complications arising in the hospital. We coded data in all countries with a standard protocol by use of variants of the ninth or tenth version of the International Classification of Diseases.[26] Researchers are not able to validate coding in administrative hospital discharge files. Countries can have validation protocols for administrative data but this information is not available. Findings of studies in Europe show that routinely collected administrative data predict risk of hospital death with discrimination similar to that obtained from clinical databases.[27] We restricted hospitals to those with 100 or more targeted patients. The primary outcome measure was whether patients died in the hospital within 30 days of admission. Risk adjustment variables included patient age, sex, admission type (emergency or elective), 43 dummy variables suggesting surgery type, and 17 dummy variables suggesting comorbidities present at admission, which are included in the Charlson index.[28]

Nurse staffing and education measures were derived from responses to surveys of nurses in each hospital with the RN4CAST nurse survey instrument.[22] The term nurse refers to fully qualified professional nurses. In all countries except Sweden, hospitals were sampled in different regions, after which a variable number of adult medical and surgical wards were randomly sampled in each hospital, depending on hospital size (between two and six wards in each hospital in every country except England, where all wards were sampled, up to a maximum of ten). All nurses providing direct patient care in these wards were surveyed. In Sweden, all hospitals and all medical and surgical wards were included by sampling all medical surgical nurses nationally.

In the RN4CAST study, nurse staffing for each hospital was calculated from survey data by dividing the number of patients by the number of nurses that each nurse reported were present on their ward on their last shift, and then averaging ratios across all nurse respondents in each hospital. Low ratios suggested more favourable staffing. Collection of data for hospital nurse staffing directly from nurses avoided differences in administrative reporting methods across countries and ensured that only nurses in inpatient care roles are

counted. We measured nurse education by calculating the percentage of all nurses in each hospital that reported that the highest academic qualification they had earned was a bachelor's degree or higher.

Statistical analyses

We estimated associations between nurse staffing and nurses' education and 30 day inpatient mortality for patients before and after adjusting for additional hospital characteristics and risk-adjusting for differences in patient characteristics. Hospital characteristics included country, bed size, teaching status, and technology; we defined high technology hospitals as those that undertook open heart surgery or organ transplantation. We included the hospital nurse work environment, measured by the Practice Environment Scale of the Nursing Work Index, as a control variable like in previous studies of nursing and mortality.[15] Patient characteristics included age, sex, admission type, type of surgery (with 43 dummy variables for the specific surgery types), and presence of 17 comorbidities (appendix). Because individual patient outcomes were modelled with a combination of hospital and patient characteristics, we estimated the effects of different characteristics with population average models using a generalised estimating approach and random intercept models using hierarchical linear modelling. Both approaches took into account patients being nested within hospitals, and in both types of models we included dummy variables to allow for unmeasured differences across countries. Because the results were almost identical, and the estimated effects of nursing characteristics were the same in terms of their size and importance, we show only the generalised estimating results. We tested for the effects on mortality of an interaction between nurse staffing and education, which was not significant and is not included in the results. All statistical analyses were done with SAS (version 9.2).

Role of the funding source

The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

We obtained mortality data for 422730 patients; the number of hospitals and surgical discharges varied across countries (table 1). The percentage of surgical patients who died in the hospital within 30 days of admission was 1·3% across the nine countries combined, and was lowest in Sweden and highest in the Netherlands (table 1).

Response rates for surveys of nurses ranged from less than 40% (2990 of 7741) in England, to nearly 84% (2804 of 3340) in Spain, and averaged 62% (29 251 of 47160) across the nine countries. Differences in both nurse staffing and nurse education were large both between countries and between hospitals within each country (table 2). In Spain and Norway, all nurses had bachelor's degrees. The mean age of the patient sample was 68 years (SD=10); table 3 shows other patient characteristics. Of 439800 patients studied more than 50% had orthopaedic surgeries, whereas roughly four in ten underwent general surgeries, and slightly

less than one in 10 underwent vascular surgeries. The most common comorbidities were diabetes without complications, chronic pulmonary disease, metastatic carcinoma, and cancer.

Table 4 shows results of modelling the effects of the two nursing factors (staffing and education) on mortality after adjustment for differences across countries in mortality (in the partly adjusted model) and for differences in the full set of potentially confounding factors (in the fully adjusted model). After we considered severity of illness of the patients and characteristics of the hospitals (teaching status and technology) in the adjusted model, both nurse staffing and nurse education were significantly associated with mortality (table 4). The odds ratios (ORs) suggest that each increase of one patient per nurse is associated with a 7% increase in the likelihood of a surgical patient dying within 30 days of admission, whereas each 10% increase in the percent of bachelor's degree nurses in a hospital is associated with a 7% decrease in this likelihood. These associations suggest that patients in hospitals in which 60% of the nurses had bachelor's degrees and nurses cared for an average of six patients would have almost 30% lower mortality than patients in hospitals in which only 30% of the nurses had bachelor's degrees and nurses cared for an average of eight patients. We worked out this 30% reduction (reduction in mortality by a factor of 0·70) by applying (and multiplying) the reciprocal of the OR associated with nurse staffing across two intervals (from eight to six patients per nurse) and the OR associated with nurse education across three intervals (from 60% to 30%)—ie, 1/1·068 × 1/1·068 × 0·929 × 0·929 × 0·929=0·703.

Discussion

Our findings shows that an increase in nurses' workload increases the likelihood of inpatient hospital deaths, and an increase in nurses with a bachelor's degree is associated with a decrease in inpatient hospital deaths (panel). Findings of the RN4CAST study showed more variation in hospital mortality after common surgical procedures in European hospitals than is generally understood. Variation in hospital mortality is associated with differences in nurse staffing levels and educational qualifications. Hospitals in which nurses cared for fewer patients each and a higher proportion had bachelor's degrees had significantly lower mortality than hospitals in which nurses cared for more patients and fewer had bachelor's degrees. These findings are similar to those of studies of surgical patients in US and Canadian hospitals in which similar measures and protocols were used.[14,15]

Our finding that each 10% increase in the proportion of nurses with a bachelor's degree in hospitals is associated with a 7% decrease in mortality is highly relevant to the recent decision by the European Parliament (Oct 9, 2013) to endorse two educational tracks for nurses—one vocational and one higher education.[21] In view of the RN4CAST findings, the goal of standardised qualifications of professionals as expressed in the Bologna process[29] is a long way off from being achieved. Our findings support the recent EU decision to recognise professional nursing education within institutions of higher education starting after 12 years of general education. However, our results challenge the decision to continue to endorse vocational nursing education after only 10 years of general education because this training might hamper access to higher education for nurses in some countries—eg,

Germany where no nurses in the 49 hospitals studied in RN4CAST had a bachelor's degree.[23]

The RN4CAST finding that improved hospital nurse staffing is associated with decreased risk of mortality might be inconvenient in the present difficult financial context and amid health-system reforms to shift resources to community-based settings. Nevertheless, this study is the largest and most rigorous investigation of nursing and hospital outcomes in Europe up to now, and has robust results. Our findings reinforce those of smaller studies in Europe,[8–11] and a large body of international published work.[12,14] Our data suggest a safe level of hospital nurse staffing might help to reduce surgical mortality, as called for by the European Surgical Outcomes Study.[3]

Beyond improvements in care, investments in nursing could make good business sense. In the USA, each US$1 spent on improvements to nurse staffing was estimated to return a minimum of $0·75 economic benefit to the investing hospital, not counting intangible benefits.[30] Furthermore, a move from less qualified licensed vocational nurse hours to qualified professional nurse hours is estimated to save lives and money.[31] Improved nurse staffing in US hospitals is associated with significantly reduced readmission rates, which is compelling in view of financial penalties in 2013 to 2225 hospitals for excessive readmissions.[32] Although hospital finance and payment policies differ between the USA and Europe, the underlying goal of better value for investments is the same.[33]

Our study has several limitations. We assessed one outcome, mortality, and only in patients undergoing common general surgeries. Our measure of education relied on each country's definition of bachelor's education for nurses, which differs by country. Our global measure of nurse staffing shows nurse workloads across all shifts, and might be skewed in some hospitals if nurses working at night (when patient-to-nurse ratios are higher than in the day) responded to our survey at different rates than nurses on day shifts. The models we used to measure associations allowed us to control for unmeasured differences in mortality across countries and for measured differences across patients and hospitals, but unmeasured confounding factors at the individual, hospital, and community level could have affected our results. We cannot link the care of individual patients to individual nurses. Additionally, mortality outcomes for patients were taken from the year that most closely matched the nurse survey year, but because of lags in patient data availability, the two data sources were not always perfectly aligned. Finally, our data are cross-sectional and provide restricted information about causality.

Additional research in Europe is needed to establish whether our multicountry findings can be replicated for high mortality surgeries and for medical patients; and whether in Europe, like in the USA, nursing is related to a range of adverse outcomes that contribute to high costs. Longitudinal studies of panels of hospitals would be especially valuable to help to establish causal associations between changes in nursing resources and outcomes for patients. Comparative effectiveness research is needed to identify what workforce investments return the greatest value, and under what circumstances. Research beyond simple mortality outcomes would be welcome to help to establish standards of care by which performance of health-care organisations could be more fully assessed. In a context of

widespread health-system redesign and reforms, increased funding for studies of health workforce investments could result in high-value health care.

In summary, educational qualifications of nurses and patient-to-nurse staffing ratios seem to have a role in the outcomes of hospital patients in Europe. Previous findings from RN4CAST show that patients are more likely to express satisfaction with hospital care when nurses care for fewer patients each.[24] To add to these findings, our data suggest that evidence-based investments in nursing are associated with reduction in hospital deaths.

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RN4CAST consortium

Walter Sermeus (Director), Koen Van den Heede, Luk Bruyneel, Emmanuel Lesaffre, Luwis Diya (Belgium, Catholic University Leuven); Linda Aiken (Codirector), Herbert Smith, Douglas Sloane (USA, University of Pennsylvania); Anne Marie Rafferty, Jane Ball, Simon Jones (UK, King's College London); Peter Griffiths (UK, University of Southampton); Juha Kinnunen, Anneli Ensio, Virpi Jylhä (Finland, University of Eastern Finland); Reinhard Busse, Britta Zander, Miriam Blümel (Germany, Berlin University of Technology); John Mantas, Dimitrios Zikos, Marianna Diomidous (Greece, University of Athens); Anne Scott, Anne Matthews, Anthony Staines (Ireland, Dublin City University); Ingeborg Strømseng Sjetne (Norwegian Knowledge Centre for the Health Services) Inger Margrethe Holter (Norwegian Nurses Organization); Tomasz Brzostek, Maria Kózka, Piotr Brzyski (Poland, Jagiellonian University Collegium Medicum); Teresa Moreno-Casbas, Carmen Fuentelsaz-Gallego, Esther Gonzalez-María, Teresa Gomez-Garcia (Spain, Institute of Health Carlos III); Carol Tishelman, Rikard Lindqvist, Lisa Smeds (Sweden, Karolinska Institute); Sabina De Geest, Maria Schubert, René Schwendimann (Switzerland, Basel University); Maud Heinen, Lisette Schoonhoven, Th0065o van Achterberg (Netherlands, Radboud University Nijmegen Medical Centre).

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Panel: Research in context

Systematic review

We searched PubMed for original research articles published in English between Jan 1, 1985, and Aug 10, 2013, with the search terms (separately and in combination): “nursing”, “staffing”, “administrative data”, “outcomes”, “mortality”, “European Union”, and “cross-national” and “international.” We also did a manual search based on bibliographies of papers we found. Studies linking nursing and clinical patient outcomes were restricted in Europe to one country studies[8–11] and to research in North America.[12–17] In Europe, cross-national studies assessing how hospital nursing affects patient outcomes are restricted to assessment of outcomes based on patient or nurse report rather than objective clinical outcomes.[24]

Interpretation

We report the first study to use detailed information about nursing workforce such as staffing and education level to investigate how these factors affect patient mortality across countries in Europe. We relied on unique data from direct-care nurses collected with a common method across many hospitals in different countries. We used a standardised approach across countries to measure and adjust the risk of mortality on the basis of administrative records. Findings of our analysis of 300 hospitals in nine countries show that an increase in nurses’ workloads by one patient increases the likelihood of inpatient hospital mortality by 7%, and a 10% increase in bachelor’s degree nurses is associated with a decrease in odds on mortality by 7%. These findings emphasise the risk to patients that could emerge in response to nurse staffing cuts and suggest that an increased emphasis on bachelor’s education for nurses could reduce preventable hospital deaths.

Table 1

Hospitals sampled in nine European countries with patient discharge data, numbers of surgical patients discharged, and numbers of patient deaths (RN4CAST data)

	Number of hospitals	Mean discharges per hospital (range)	Deaths/discharges (%)
Belgium	59	1493 (413–4794)	1017/88 078 (1·2%)
England	30	2603 (868–6583)	1084/78 045 (1·4%)
Finland	25	1516 (175–3683)	303/27 867 (1·1%)
Ireland	27	738 (103–1997)	292/19 822 (1·5%)
Netherlands	22	1419 (181–2994)	466/31 216 (1·5%)
Norway	28	1468 (432–4430)	518/35 195 (1·5%)
Spain	16	1382 (186–3034)	283/21 520 (1·3%)
Sweden	62	1304 (295–4654)	828/80 800 (1·0%)
Switzerland	31	1308 (158–3812)	590/40 187 (1·5%)
Total	300	1308 (103–6583)	5381/422 730 (1·3%)

Only hospitals with more than 100 surgical patient discharges were included in the analyses. Data shown are for discharged patients for whom information about 30 day mortality, age, sex, type of surgery, and comorbidities were complete. Data were missing for those characteristics for less than 4% of all patients.

Table 2

Nurse staffing and education in nine European countries

	Nurse staffing (patients to nurse)		Nurse education (% of nurses with bachelor's degrees)	
	Mean (SD)	**Range**	**Mean (SD)**	**Range**
Belgium	10·8 (2·0)	7·5–15·9	55% (15)	26–86%
England	8·8 (1·5)	5·5–11·5	28% (9)	10–49%
Finland	7·6 (1·4)	5·3–10·6	50% (10)	36–71%
Ireland	6·9 (1·0)	5·4–8·9	58% (12)	35–81%
Netherlands	7·0 (0·8)	5·1–8·1	31% (12)	16–68%
Norway	5·2 (0·8)	3·4–6·7	100% (0)	100–100%
Spain	12·7 (2·0)	9·5–17·9	100% (0)	100–100%
Sweden	7·6 (1·1)	5·4–9·8	54% (12)	27–76%
Switzerland	7·8 (1·3)	4·6–9·8	10% (10)	0–39%
Total	8·3 (2·4)	3·4–17·9	52% (27)	0–100%

Means, SDs, and ranges are estimated from hospital data—eg, the 59 hospitals in Belgium have a mean patient-to-nurse ratio of 10·8, and the patient-to-nurse ratio ranges across those 59 hospitals from 7·5 to 15·9. Similarly, the 31 hospitals in Switzerland have, on average, 10% bachelor's nurses, and the percent of bachelor's nurses ranges across those 31 hospitals from 0% to 39%.

Table 3

Characteristics of surgical patients (n=422 730) in the study hospitals

	Number (%)
Men	189 815 (45%)
Emergency admissions	141 584 (34%)
Inpatient deaths within 30 days of admission	5381 (1·3%)
Surgical categories	
General surgery	162 974 (39%)
Orthopaedic surgery	220 301 (52%)
Vascular surgery	39 455 (9%)
Comorbidities	
Cancer	15 297 (4%)
Cerebrovascular disease	7400 (2%)
Congestive heart failure	10 274 (2%)
Chronic pulmonary disease	28 373 (7%)
Dementia	5744 (1%)
Diabetes with complications	6478 (2%)
Diabetes without complications	35 450 (8%)
AIDS/HIV	50 (0%)
Metastatic carcinoma	17 911 (4%)
Myocardial infarction	12 002 (3%)
Mild liver disease	5953 (1%)
Moderate or severe liver disease	1354 (0%)
Paraplegia and hemiplegia	2043 (1%)
Peptic ulcer disease	2323 (1%)
Peripheral vascular disease	12 452 (3%)
Renal disease	10 085 (2%)
Connective tissue disease or rheumatic disease	6962 (2%)

Table 4

Partly and fully adjusted odds ratios showing the effects of nurse staffing and nurse education on 30 day inpatient mortality

	Partly adjusted models		Fully adjusted model	
	OR (95% CI)	**p value**	**OR (95% CI)**	**p value**
Staffing	1·005 (0·965–1·046)	0·816	1·068 (1·031–1·106)	0·0002
Education	1·000 (0·959–1·044)	0·990	0·929 (0·886–0·973)	0·002

The partly adjusted models estimate the effects of nurse staffing and nurse education separately while controlling for unmeasured differences across countries. The fully adjusted model estimates the effects of nurse staffing and nurse education simultaneously, controlling for unmeasured differences across countries and for the hospital characteristics (bed size, teaching status, technology, and work environment), and patient characteristics (age, sex, admission type, type of surgery, and comorbidities present on admission). OR=odds ratio.